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ANNUAL INVESTIGATIVE REPORT FOR 1927

and

PROGRAM FOR 1928

NORTHERN DISTRICT
AND
NORTHERN ROCKY MOUNTAIN FOREST EXPERIMENT STATION
MISSOULA, MONTANA

GOVERNMENT PRINTING OFFICE 8—5156

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ANNUAL REPORT OF DISTRICT I INVESTIGATIVE COMMITTEE FOR 1927

AND PROGRAM FOR 1928

PERSONNEL OF THE COMMITTEE

The annual meeting of the Investigative Committee of District 1 of the Forest Service was held in Missoula, Montana, January 12, 13, and 14 at Pinchot Hall, University of Montana. The voting membership of the Committee consisted of:

Fred Morrell, Chairman	District Forester
R. H. Weidman, Secretary	Experiment Station
Elers Koch	Management
W. W. White	Management
M. I. Bradner	Products
H. R. Flint	Operation
T. Lommasson	Grazing
H. T. Gisborne	Experiment Station
D. S. Olson	Planting
W. M. Nagel	Forest Supervisor

Other members of the Forest Service who attended part or all of the sessions were: Robert Marshall and G. Kempff of the Experiment Station; I. V. Anderson and C. N. Whitney of Products; L. C. Stockdale and R. N. Cunningham of Operation; C. S. Webb of Management; Theo. Shoemaker of Public Relations; and Forest Supervisor L. G. Hornby. Representing agencies outside the Forest Service there were in attendance the following: J. C. Evenden of the Bureau of Entomology; S. N. Wyckoff and C. H. Johnson of Blister Rust Control; J. M. Sherier and E. M. Keyser of the Weather Bureau; State Forester Rutledge Parker of Montana; Dr. E. E. Hubert of the University of Idaho (Forestry School); Dean T. C. Spaulding and Professors Skeels, Cook, Ramskill, Clark (Forestry School), and Doctor J. E. Kirkwood and Professors J. W. Severy and C. W. Waters (Botany Department) of the University of Montana. State Forester Ben E. Bush of Idaho was unable to attend.

The presence of this group of thirty-four men made possible a rather comprehensive presentation and discussion of the forest research work being conducted by the various agencies in the region, and brought to light additional opportunities for co-operation and co-ordination.

MATTERS OF GENERAL INVESTIGATIVE POLICY

Regarding the Function of the Committee

The question was raised this year and last whether the present deliberations of the District Investigative Committee have not come a long way from serving the purposes originally intended. It was stated that originally the Committee reviewed the problems of the region, discussed their priority, and then recommended the projects to be undertaken during the year. The Committee thus drew up the program of work

for the year. According to the National Forest Manual this to some extent still seems to be the official function of the Committee. In actual practice, however, each office now brings to the meeting a fully prepared program of work for the year, which in ninety-nine cases out of a hundred passes unchanged into the annual report and program for the Forester's approval. Thus the Committee's discussion of the research work of the District seems to have become mainly informational in character. One answer to this is that the several units which actually conduct the research work have developed greatly since the days of the first District Investigative meetings, not only in number, training and experience of workers, but in technique and the capacity to recognize the needs of the region and to plan adequately for meeting these needs.

Forest Research by Various Agencies in the Region

To get an idea of the regional research activities as reflected by their costs, each agency represented at the meeting this year was asked to submit estimates of funds expended annually on forest research in the northern Rocky Mountain region. The resulting information showed the interesting total of $88,000 for Federal and State research. This amount is expended as follows: Forest Service 43 per cent; Blister Rust Control 35 per cent; University of Idaho 10 per cent; Bureau of Entomology 7 per cent; University of Montana 3 per cent; and Weather Bureau 2 per cent. The figures do not include funds of the Forest Products Laboratory devoted to utilization problems in this region or funds of the Washington Office devoted to a considerable amount of computing work on several important regional projects. There is also a small amount of funds spent on private research in the region which is not included in these figures. The estimates were prepared somewhat hurriedly on the basis of a rather sharp distinction between administrative experiments and more systematic research, and were generally thought to exclude too much of experimentation which really should have been classified as research.

Appointment of Subcommittees

To give further consideration to the several matters just discussed, and to report in advance of the next annual meeting, the Chairman appointed two subcommittees. The first committee, consisting of Koch, Flint and Gisborne, is to examine into the functions and efficiency of operation of the District Investigative Committee and to prepare an outline for conducting the next meeting. The idea is to make the meeting more effectively serve the present-day needs. The purpose of the second committee, consisting of Weidman, Wyckoff, Spaulding, and Hubert, is to obtain the data and submit a report on the basis of which the Investigative Committee may determine whether emphasis by funds and lines of work is being properly and proportionately placed according to the regional needs. To do this, the Committee is to define research as distinguished from extension and administrative experimentation and to collect on this basis the figures on expenditures. There was a feeling that some of the work which is being reported as research is really fit-and-try experimentation, and some of it is too poorly controlled to deserve the characterization of research.

Progress in Establishing Permanent Sample Plots

Altogether 11 permanent sample plots and over 600 reproduction quadrats were established by the Experiment Station in 1927. Seven of

the larger plots are devoted to the study of reproduction following forest fires and logging, three to methods of cutting, and one to yield. Three of the sample plots on fresh burns, comprising 21 acres, were so installed as to give data on fire damage, as well as reproduction. Not included in this enumeration are two methods-of-cutting plots partially established in the late fall, on which work will be completed in the spring. All these plots are located in the Priest River Experimental Center, some on the Demonstration Forest and the remainder at various points within a radius of 30 miles by automobile. Of the total number of larger permanent sample plots so far established, 40 are located in the Priest River Center and 18 in the Coeur d'Alene Experimental Center.

Regarding a District 1 Fire Bulletin

The proposal to prepare District 1 fire statistics for publication as a bulletin by Flint and Gisborne was again brought before the Committee and discussed in some detail. Most of the men here cannot see the need of such a bulletin and feel that time devoted to it would be given at the expense of more important lines of research work. The Committee voted five to three against preparing a bulletin.

Early Publication of Nursery Bulletin Urged

Olson's manuscript on forest nursery practice has just been submitted for publication as a bulletin. This report contains the accumulated knowledge on methods, equipment, and technique developed through many years' experience at Savenac Nursery, and should prove highly valuable to forest nurserymen throughout the country. In view of the great need for this sort of information in the next year or two due to the establishment of numerous Clarke-McNary Act nurseries, it is hoped that Olson's manuscript may be hastened on the road to publication.

RESULTS AND PLANS OF CURRENT PROJECTS

Seed Studies

Routine seed testing required at Savenac Nursery is being done by a co-operative arrangement at Oregon Agricultural College. Through the courtesy of the University of Montana, Marshall is conducting such seed testing as is necessary for the Experiment Station in the laboratory of the School of Forestry.

In the way of a project, there is only one under this heading which is conducted by the Forest Service. This deals with source-of-seed plantations at Priest River Experiment Station containing 21 plots, the first of which were established in 1911. The plots represent the races of western yellow pine from 19 localities over a wide range of country, from the Black Hills to the Siskiyou Mountains and from northern Idaho to Arizona and New Mexico. An examination of the plots was made in 1927, the main conclusions of which are that temperature (especially the extremes) has exerted a greater influence than other meteorological factors in the local adaptation of the different strains, and that seed collected north of a line through the Black Hills and Blue Mountains has produced hardier, thriftier, and more rapid growing trees than the seed from south of that line. The work also indicates, but does not prove, that seed from

the local region produced the best progeny when it was collected from parent trees growing between an altitudinal range of 2500 to 5500 feet.

Under the direction of Professor Skeels, of the University of Montana, student tests are being made of various methods of stimulating the germination of seed of about sixty western Montana species of shrubs, vines, and small trees. From five to twenty methods of treating each species are being employed.

An administrative study of the yield of seed from cones of various age classes in western white pine is proposed by Olson but may not be undertaken for a year to two because of the press of other work.

Nursery Practice

During 1927, field work was done on only two nursery projects; the hardening-off and the root-control studies. In the former, an examination was made of 1,400 specimens of 1-2 yellow pine and an equal number of the same class of white pine which had been field planted in 1926 from plots treated in the nursery in various ways to prepare the stock for the shock of changing from the nursery to the planting site, and to prepare the stock for the rigors of winter. The results of this examination were sent to Wahlenberg for incorporation in his report on this project.

As a part of the study of root control, examination was made of 1,200 field-planted 3-0 yellow pines, and the results forwarded to Wahlenberg. During 1928, laboratory measurements will be made of stock transplanted two years ago at various depths and with various lengths of roots. Except for these laboratory measurements, there will be no field work on old nursery projects this year.

Before his transfer to the Southern Experiment Station, Wahlenberg prepared final reports on the following projects, which are now considered as closed:

1. Effect of the amount of seed sown to the density of seedlings on the later development and survival of western yellow pine, western white pine, and Engelmann spruce.

2. The influence of the size of western yellow pine seeds on the behavior of forest planting material.

3. Experiments in the use of fertilizers in growing forest-planting material at Savenac Nursery.

4. Investigations in chemical weed control at Savenac Nursery.

5. Experiments with classes of stock suitable for forest planting in the northern Rocky Mountains.

6. Effect of Ceanothus brush on western yellow pine plantations.

As previously mentioned, Olson's manuscript on nursery practice in this region has been submitted for publication as a Department bulletin.

Although both forest schools have nurseries and are running nursery tests of various kinds, no projects strictly of a research character are being conducted. In the products laboratory at the University of Idaho a small study is being made of the relative water-absorbing and holding capacity of various tree-packing materials for shipping nursery stock.

Sowing and Planting

A new administrative project, to be conducted on a small scale, is proposed by Olson. This is a study of survival on grassy bottom and bench land according to different methods of planting, such as scalping the sod with a mattock, scalping and cultivating with a mattock, and planting in a plowed furrow. Three species, white pine, yellow pine, and spruce, will be used.

The University of Idaho has three planting studies under way. One is to determine the influence of windbreaks on the growth and yield of farm and orchard crops. One phase of this project includes a determination of the best tree species to use and the methods of planting and cultivation. The second project includes tree plantations on alkali soils. This is co-operative work between the School of Forestry, the University Extension Division, and the Idaho Agricultural Experiment Station. Twenty species of hardwoods and conifers are to be planted in the spring of 1928, on a plot known to contain alkali in various concentrations. A control plot will be established on a nearby area known to be free from alkali. The third project is a co-operative one between the School of Forestry and several other agencies in southern Idaho. The purpose is to determine the species of forest and shade trees which will thrive best on the present waste land at high altitudes in that region. Planting is to commence in the spring of 1928.

Methods of Cutting

There are two projects of this sort on the program, one conducted by the Experiment Station and one by the Office of Management. The University of Idaho also has one methods-of-cutting project.

The Experiment Station project is confined to the western white pine type and has two phases, one dealing with permanent sample plots and the other with the study of conditions on old timber-sale areas. The work in 1927 was confined to permanent sample plots. It involved the establishment of three new plots and the annual examination of three previously installed.

One of the new plots represents the heavy marking practiced on the Idaho State timber sale in Big Creek. This plot contains three white pines per acre over 16 inches in diameter, in contrast to a plot established in 1926 containing six white pines per acre over 16 inches in diameter, and representing standard marking on National Forest timber sales. The other two plots established in 1927 are a parallel set devoted to the understory problem, in which one has the understory left intact and the other has it removed. The object is to determine whether it is better practice economically and silviculturally to secure the next harvest from a new crop or from the understory stand. It is important to

mention that the new crop started on bare ground has an excellent chance of containing a large percentage of western white pine, whereas the underwood stand is made up of hemlock, fir, and cedar (partly suppressed and fungus infected) which will largely hinder or prevent the starting of white pine reproduction.

The re-examinations were made on the standard seed-tree and hemlock-disposal plots established in 1926, and reveal what has happened during the year in the way of seed production and regeneration. On all the plots the cone crop in 1927 was poor and patchy compared with excellent in 1926. By species, seed production last fall was poor for white pine, larch, and Douglas fir, none for white fir, and fair for cedar, hemlock, and Engelmann spruce. The reproduction record for the standard seed-tree plot shows white pine seedlings to the number of 190 per acre started in 1926, and 1390 per acre in 1927. There was 17 per cent mortality of the 1926 crop of reproduction. On the two hemlock-disposal plots the examination of 1926 showed a total of only 50 seedlings per acre, whereas the count a year later shows that 31,825 seedlings per acre started in 1927. Of this huge crop of reproduction, 80 per cent is cedar, 16 per cent hemlock, 2 per cent white fir, 1 per cent white pine (300 seedlings per acre) and the remainder larch, fir and spruce. Practically all the cedar started on the spots where slash was burned in piles. On the standard seed-tree plot all of the 19 girdled hemlock (16 inches to 34 inches D.B.H.) were tagged for periodic examination. Only three of these are dead one year after girdling. The seed production of these trees is of interest. On the basis of good, fair, poor, and none, seven of the girdled hemlocks bore a good cone crop in 1927, whereas only three bore a heavy crop at the time of girdling in 1926. Another interesting observation is that five of the heavy bearers in 1927 were poor seed producers in 1926. On the other hand, the three heavy bearers in 1926 bore poorly or not at all in 1927. This seems to be further evidence that girdling stimulates seed production.

It is believed that the Experiment Station plans for 1928 should include activity on both phases of the methods-of-cutting project, with greater emphasis on the study of old timber-sale areas. A full season of field work was devoted to the latter study in 1925, when 15 areas in the white pine type were covered intensively and the results, in the form of a preliminary report, were prepared and made available to Forest Management and the Kaniksu and Coeur d'Alene Forests. In this study temporary strips were run across the areas on which reproduction quadrats were taken at intervals, and the trees of the residual stand were tallied and bored for increased growth. Seedlings on the quadrats were analyzed for age, species, and number per acre. The main objects were to determine the character of the reproduction which had become established, and the condition, as well as the relationship to reproduction, of seed trees and residual stands. The work in 1925 furnished very useful information, and it has been the plan since then to do another full season of work on this study. It is believed this should be done in 1928.

The methods-of-cutting project listed by the Office of Management is closely parallel (although less intensive in its methods) to the Experiment Station study of old-timber-sale areas. The original idea was to have local Forest officers carry out a survey of reproduction and reserved tree conditions on timber-sale cuttings following an outline

prepared by Management. The project was launched in 1926, but progress has been discouragingly slow and Koch is now convinced that some other procedure is necessary if the work is to be done and the most is to be gotten out of it in the way of silvicultural information. He proposes a co-operative effort on the part of Management and the Experiment Station, whereby all the important timber-sale areas in the western white pine type can be covered in 1928. This proposal whould mean that, in addition to the Experiment Station party, Management would place a party in the field consisting of White and one or two field assistants to be financed by District funds. A uniform outline of instructions would be followed for the main objectives and the Experiment Station would do the office work leading to a comprehensive report for the study as a whole. The Committee did not entirely agree in the discussion of this proposal. The District Forester felt that this way of conducting the study would sacrifice one of its desirable features, viz., technical training of timber sales personnel by actual participation in the work. But the failure of the local men to find time for the work during the past two years is just the reason for the discouraging progress and for Koch's present proposal. The discussion ended with a statement by the District Forester that he would decide the matter administratively when the request came to him for funds to finance the work as proposed.

The Committee agreed on the high priority of studying old timber-sale areas, not only because it is desirable to know which of our cut-over areas are successfully reproducing, but also because it is necessary to know why reproduction has or has not been obtained, so that present marking, cutting, and brush disposal practices may be modified on the basis of this knowledge. Mr. Wyckoff mentioned that considerable information concerning Ribes growth on cut-over areas might be obtained in this work, and suggested that Blister Rust Control might be able to add a man to the field party if it were found to be desirable and efficient. In this connection also, Cunningham suggested that it would be highly desirable to extend the study to some cut-over areas outside the National Forests in order to determine what is happening after the heavy cutting practiced on private lands. As the work to be done on timber-sale areas will obviously take all the time that the Experiment Station and Management has available, it was asked whether the University of Idaho would not consider undertaking a reproduction study on the private cut-over lands. Hubert stated that the University would be in sympathy with the idea, but that it really has a rather heavy research program, a part of which is devoted to the permanent sample-plot phase of methods-of-cutting studies. As the matter stands, the Experiment Station is definitely ready to undertake its study on old timber-sale areas, but there is some uncertainty whether Management and the University of Idaho will be able to carry out the additional activity proposed. If possible, the Experiment Station will include one or two private cuttings in the areas to be studied by its field party.

In connection with establishing additional permanent sample plots, the plan of the Experiment Station will be to concentrate members of its staff on this whenever it is convenient to do so. For example, three plots can be established next spring when the staff is to be assembled at the Priest River Station during the field trip there of the University of Idaho forestry students. If possible, an effort will be made in the fall to establish a series of methods-of-cutting plots on the Coeur d'Alene Forest.

There are no such plots in that region, and it is very desirable that the series established on the Kaniksu Forest should be duplicated there.

The University of Idaho project consists of six permanent sample plots on land of the Clearwater Timber Company. The timber was cut to diameter limits of 12 and 14 inches, and the plots were installed with the object of observing the growth and development of the remaining stands and the establishment of reproduction.

In connection with the permanent plots of the Experiment Station dealing with hemlock disposal, Hubert suggested that it might be possible to study the spread of heart rot from girdled and felled hemlock to young and sound remaining trees of this species. There is an excellent opportunity for this on several of the plots already established and definite steps will be taken to get Hubert's co-operation in putting the suggestion into effect next spring.

Natural Reproduction

The Experiment Station is the only agency in the region studying reproduction after forest fires and the fundamental conditions which control germination and survival either after fires or after logging. The work, although listed as a single project, has several rather distinct phases and employs various methods of research. The Custer National Forest carries a project dealing with the encroachment of yellow pine reproduction on grasslands, upon which very little work appears to have been done.

The Experiment Station project dealing with the study of reproduction after logging and forest fires was the most active field study on the program last summer. Because the large fires of 1926 made available excellent conditions for it, most of the work was done on burns. The several steps in the process of regeneration which are being studied are: production, dispersal, storage and germination of seed, and the establishment of seedlings. Source of reproduction, as represented by production, dispersal, and storage of seed, is still the important problem to be solved in the western white pine type and is the one which at present is being given most attention in this study. The known possible sources are: (1) seed stored in the duff previous to logging or fire; (2) seed shed at the time of the fire by fire-killed trees; (3) seed shed after the removal of the main stand by trees which were left in logging or which survived the fire.

Seven permanent sample plots were established on the Kaniksu Forest last summer as follows: three totaling 21 acres, located on 1926 burns containing scattered seed trees; two consisting of five strips of quadrats 800 to 1900 feet long on 1926 burns with seeding from the side; two totaling nine acres, on 1926-1927 logged areas with scattered seed trees. In order to isolate reproduction from seed shed after fire or logging from that originating from stored seed and seed shed at the time of the fire, the method of parallel screened and unscreened quadrats was employed. All the plots were stripped or gridironed with these pairs of screened and unscreened quadrats, and altogether 498 such quadrats were installed last summer. About 25 additional quadrats were established to test out the starting of reproduction on spots where slash piles had been burned, on spots where the duff had been purposely scarified, and on other spots where it had been entirely removed by hand to the mineral soil. In addition,

40 seed traps were set out under conditions of seeding from the side and from scattered seed trees. Some of the quadrats will be examined twice a yaar tc get the germination and mortality within the growing season, and others will be examined each fall only. The seed traps will be examined at 10-day intervals from the time the cones open until the traps are covered by snow. All living trees on the plots over 10 inches D.B.H. were tagged and described in detail as to damage and seed production. These also are to be examined annually in the fall. The numerous reproduction quadrats located on methods-of-cutting plots are also examined annually and contribute to the results of the present project.

There is not space here to report on the records resulting from the establishment and examination of the various plots and quadrats. It might be stated, however, that the combination of an excellent seed crop in 1926 and highly favorable moisture conditions in 1927 has given rise to a heavy catch of reproduction on the burns. The plot which contained the most reproduction showed 575,000 seedlings per acre, with red cedar making up 329,000, hemlock 207,000, white pine 11,500, larch 11,000, spruce 10,000, white fir 6,000, and Douglas fir 500. These figures are based on 62 milacre quadrats located on an eight-acre plot.

Additional activity on this study during 1927 included an experiment dealing with seed storage to determine how many years seed will remain viable in the duff, and another experiment devoted to determining the effects of fire on stored seed. The first experiment represents a comprehensive installation consisting of eight compartments, each containing eight subcompartments. In each compartment six of the constituent parts received separately 1000 seeds of white pine, larch, Douglas fir, white fir, cedar and spruce, and the remaining two compartments were reserved as checks on the amount of seed the unsown duff contained. The whole installation was protected by screening against rodents and the entrance of additional seed. One compartment will be taken up each year for eight years, the seed sifted out and given a greenhouse test for germination per cent. This experiment is a continuation of the work of Brewster and Larsen, whose original efforts to solve the problem of seed viability (continued through a number of years) were thwarted by unforeseen difficulties and undeveloped technique.

The experiment dealing with the effects of fire on stored seed involved four tests with slash piles and one with a broadcast slash burn. In all cases temperatures were measured with a thermo-electric pyrometer at the surface and at different levels in and under the duff where seed may possibly be stored naturally. In the case of the slash piles the maximum temperatures reached were 680 degrees C. in the hottest part of the fire, 610 degrees at the surface of the duff, 466 degrees between the duff and humus, and 446 degrees between the humus and mineral soil. The duration of temperatures above 60 degrees C. (the approximate killing point for plant tissue) was $8\frac{1}{4}$ to 20 hours at the surface, 23+ between the duff and humus, and $17\frac{1}{2}$+ between the humus and mineral soil. The plus means that the observer discontinued instrument readings at this time, the temperature still being above 60 degrees, but showing a definite and slow downward trend. In the case of the broadcast slash burn the temperature was taken at the top and bottom of the duff under a heavy cover of slash, such as might be found adjacent to a skid road, and under very light slash where the fire merely scorched the duff. Under heavy slash the maximum

temperatures attained were 674 degrees at the surface of the duff and 190 degrees below the duff; under light slash the maximum temperatures reached were 470 degrees and 56 degrees respectively. These preliminary tests indicate that there is no chance of seed in the duff or humus remaining viable under a burning slash pile, and that the only chance in a broadcast burn is under a cover of very light slash. As a check on this, 1,000 white pine seeds were placed in the duff on both the lightly and heavily burned spots in the broadcast area. These have been recovered and are now undergoing germination tests.

The work on the natural reproduction study, in addition to periodic re-examinations of the present plots and quadrats, which is indicated as advisable to undertake in 1928, includes the following:

(1) The establishing of one or two additional plots with screened and unscreened quadrats on a freshly logged area.

(2) The installation of one or two plots with screened and unscreened quadrats immediately before and after a fire, so that the reproduction coming from fire-killed trees may be definitely isolated from that resulting from stored seed and from later seeding of surviving trees.

(3) A somewhat similar installation immediately before logging in order to isolate from stored seed the seed which is shed by the full overwood during the year of logging.

(4) The establishment of one or two additional seed-storage experiments, similar to the one initiated in 1927. Due to the factor of chance, a number of these tests are essential before any definite conclusions can be reached.

(5) Further tests with the thermo-electric pyrometer to determine the heat under fires. These should be conducted at different times of the year so as to embrace different moisture conditions. In view of the fact that the few tests so far made seem to indicate that there is no chance of seed surviving under burning slash piles, these tests need receive little further attention. The effort should be concentrated on broadcast slash burns and forest fires.

(6) The selection of a better site for seed-dispersal tests than the one now established, and removal of the seed traps to that site.

(7) The placing of seed traps in a mature stand and a 75-year-old stand, to determine in each case the amount of seed shed per acre, and the period of shedding. These traps should be kept in place for years in order to determine the relation of seed production to climate and age of stand.

(8) The sowing of definite quantities of seed of all important indigenous species on prepared surfaces similar to the ones found in nature: unburned duff, scorched duff, completely burned duff, mineral soil, charcoal, heavy ashes, dry wood. Thus only can be obtained a scientific measure of the germination and establishment of seedlings as influenced by soil surface, and elimination of most of the variables

which interfere with interpreting results on the existing sample plots.

(9) The artificial dispersal of seed from a kite or a balloon at the height of a tree, and the measurement of the distance and direction of seed dispersal. This will help to solve the problem of the effective seeding range of a tree. The Pacific Northwest Experiment Station, in view of the previous work it has conducted along this line has volunteered to carry out this project for us while testing some of their own seeds.

(10) In order to find out whether trees girdled by fire at different times of the season will mature their cones, it is proposed to girdle several cone bearers at different times during the summer -- June 15, July 1, July 15, and August 1, for instance. Just before the normal period of dispersal the cones will be collected and their seeds then extracted and germinated.

Thinning

There are two thinning projects on the program: one in white pine conducted by the Experiment Station, and one in western yellow pine conducted by the Custer Forest.

The white pine project comprises 11 plots on the Priest River demonstration forest established between 1924 and 1925. The last measurements were taken in 1924 and 1925, and compilation of the data has awaited the appearance of the new second-growth volume tables this winter. The volumes for the plots have now been computed and the preparation of the report is under way.

The western yellow pine project on the Custer Forest consists of six plots established in 1918 and 1921. Remeasurements were made in 1926 and 1927 and a progress report is in course of preparation.

Volume, Growth and Yield

The program carries two projects of this sort: one by the Experiment Station and one by the Office of Management. The University of Idaho lists two projects and the University of Montana is also collecting growth and yield data.

The Experiment Station project deals with the preparation of normal yield tables and volume tables for the western white pine type and has been one of the major activities of the Station for the last three years. The first stage of the study in the form of final tables was brought to a conclusion last fall. A vast amount of field and office work has been devoted to the collection and compilation of the data. The office work alone was an immense task which required the services of a number of people in the computing section of the Washington Office for about six months. The results now available are a complete and up-to-date series of mensuration tables for the western white pine type. These include the normal yield tables for all sites, in terms of cubic feet and board feet, Scribner and International 1/8" rules. They also include the usual height, diameter,

and basal area tables. In addition, they include new second-growth volume tables for six species in cubic and board feet (Scribner and International 1/8" rules) and in total and merchantable height. The preparation of the volume tables was a big job in itself, made necessary by the lack of tables in this region for accurately computing the volumes of young stands.

The second stage of a normal yield study deals with the methods of applying the tables to natural stands. This means field work in stands of various stocking with a view to determining correction factors. Such correction factors must be determined before applying either normal or empirical yield tables. For several reasons it is believed best to postpone for the present an application study for this region. These are: more urgent need for work on the reproduction and methods-of-cutting studies, and the fact that the Pacific Northwest Forest Experiment Station is now engaged on an application study which may indicate the solution of the problem for this region. In the meantime, the conventional basal-area method of applying normal yield tables can be used with such corrections as are indicated by conditions on the ground.

The Experiment Station also has permanent sample plots devoted to the study of growth and yield. Only one new plot of this sort was established in 1927. This is a small plot in a 29-year-old stand containing white pine, larch, Douglas fir, white fir, hemlock and cedar. One of the purposes in establishing this plot was to get an idea of the technique involved in a study of changes in composition of young stands. One of the chief objectives is to learn whether white pine increases or decreases in proportion to the other species as young stands advance toward rotation age. This work has given some ideas of what should be done and is a study of the sort the Office of Blister Rust Control has several times proposed as necessary to determine under what conditions of young stands Ribes eradication should be undertaken.

The plans for 1928 require the remeasurement of 17 yield plots established five years ago on the Coeur d'Alene Forest. Eight of these plots must be examined in the spring before the new growing season commences, and nine of them in the fall. It has been the plan for some time to round out the present series of permanent yield plots by establishing several additional plots in the age classes between 25 and 40 years. It is hoped that an opportunity will be afforded to put in a few of these plots in 1928.

The project conducted by the Office of Management deals with the rate of growth of remaining trees after logging in lodgepole pine. A little field work is done each year by White with the assistance of local Forest officers. As a result of several weeks' work on the Gallatin Forest in 1924 and 1925, increment core measurements were secured on about 1200 trees in old cuttings. A brief progress report was prepared in 1926. In 1927 increment cores were secured from 263 trees on the Deerlodge Forest. The study was extended to old western yellow pine cuttings in the Coeur d'Alene Lake region in 1927, where White and a local Forest officer secured increment cores from 666 trees. It is proposed to work up the data this winter by detail of a man from the field.

Another line of work under the heading of volume, growth and yield is the checking and revision of the District volume tables for mature timber. The Office of Management has assigned a man to the job this winter who is working in co-operation with the Experiment Station. The task consists chiefly of checking the existing volume tables to determine whether new tables are necessary or correction factors for certain localities will suffice.

The two projects conducted by the University of Idaho are the following:

(1) A study dealing with the preparation of empirical yield tables for even-aged white pine stands. Two sets of tables are to result from this study. One is to apply to the Potlatch region and is based on strips through some 200 forties in 20 to 80-year-old stands. The field work was done several years ago by Watson and the material is now being prepared for publication as a University bulletin. The other set of tables will apply to the stands of the Clearwater Timber Company and will be based on a large number of plots. Field work was done last summer by Nettleton and Wiesehuegel in co-operation with the Clearwater Timber Company and Mason and Stevens, five men having been engaged on the job for nearly three months. Data were collected on about 300 quarter-acre plots.

(2) A study of rate of growth on remaining trees after logging in order to determine the yield to be expected from residual stands in the white pine type. Several years' field work by Nettleton on areas logged 18 to 20 years ago. Ten sample plots selected in the course of the work on which additional measurements are to be taken this year. The material for this project is to be prepared for publication as a University bulletin in 1928.

In addition to these existing projects, the University of Idaho is to undertake work this year on two new yield projects. One of these will be a study of rate of growth of residual cedar trees in order to predict how long it takes understory trees of this species to reach commercial pole size after release by logging. The other study will deal with rate of growth of remaining trees after logging in the western yellow pine of the Craig Mountain Lumber Company, with a view to predict the time and yield of a second cut. This study will also produce stand tables in order to determine before cutting potential remaining stands by certain diameter limits. All the data will contribute toward determining under what conditions, if any, this company could operate on a sustained yield basis.

The University of Montana has a project, the aim of which is to prepare normal yield tables for western yellow pine in even-aged stands. As the data must be collected by students as a part of their regular instruction, only a limited number of plots can be taken each year. Fifty-six plots were taken in 1927. To obtain the required data for three site classes will require three or four years more. Some study is also being given to the use of the form quotient in estimating the board-foot contents of standing timber.

Fire Studies

The Experiment Station continues to carry three projects under this head. The Office of Operation, the Weather Bureau and the University of Idaho also perform certain lines of investigation, to greater or less degree, which bear on the regional problem of fire control. The research on wood moisture by the University of Montana has so changed during the year that it now applies more completely to products than fire studies.

The Experiment Station projects deal with: (1) the relation of weather elements to the inflammability of forest fuels; (2) lightning as a cause of forest fires; (3) weather forecasting.

The most noteworthy progress during 1927 perhaps was made in the co-operative project with the Weather Bureau to improve fire-weather forecasts. Early in the season Gisborne was accompanied by Mr. Chapin of the Bureau on an inspection of the eight Forest Service weather stations which are being used as a basis for localizing the forecasts. Some new equipment, provided by the Weather Bureau, was installed at Adams, Savenac and Spotted Bear Stations (Nezperce, Lolo and Flathead Forests), and the old equipment was tested for accuracy and replaced whenever necessary. The observers were all supplied with the new form for recording observations and were instructed in the technique of measurements as well as the system of reporting by telegraph to Spokane.

As a result of this inspection and the increased experience of the field force, as well as the increased familiarity of Messrs. Keyser and Chapin with field conditions, the weather forecasts were localized more than usual and are believed to have attained a higher percentage of accuracy. A very close rating for the Nezperce Forest gave an accuracy of 84%. It is especially significant that thunderstorms occurred on 14 of the 17 days for which they were predicted and that they occurred on only one day when they were not predicted. Likewise, in seven out of eight cases the forecasts foretold the cessation of the thunderstorms correctly. This is thoroughly dependable and usable information of the kind previous investigative committees have outlined as being very desirable.

Another phase of fire-weather work which has been rather well received was the compilation by Gisborne of 10-day weather normals for stations on eight National Forests. The data were prepared in the form of promise cards to show the normal rainfall, temperature, and humidity for each 10-day period during the fire season, and the cards were dated to come to the attention of the Supervisor at the beginning of each period. By such a method, the normal trend of the weather was made known more accurately than heretofore, and by 10-day periods corresponding to the fire reports. As each period developed, the Supervisor was able to determine accurately whether current conditions were better or worse than normal, and the amount of variation. Supervisors who were new to their Forests were especially impressed with the advantages of this method of knowing what weather to expect and the peculiarities of the current conditions. The accomplishment of this piece of work was made possible by the Office of Operation and the Lolo Forest through the detail of men to do the mass of compilation necessary.

Due to Dean Angell's transfer from Moscow to Pocatello, nothing was done during the past year on the co-operative experiment with the University of Idaho in which the quadrant electrometer was to be used in studying the electrical conditions accompanying, and perhaps preceding, different types of weather. It may yet be possible, however, through co-operation with Dr. Hammar of the University of Idaho, to make measurements with this instrument so that the possibilities in this theory may be brought to light.

Radio reception of weather reports from Station NPG at San Francisco was again found to be successful, and it is now fairly certain that if competent meteorologists should be assigned to Forest weather stations in this region, as in the fruit-frost forecasting work in California, the basic reports needed by each of these men could be obtained consistently by radio at extremely small cost. It may be of interest to know that the Weather Bureau is planning to depend more and more upon radio transmission of reports and forecasts, and that the entire transmission of this information from district forecasters to the field may be solely by radio within the next few years. Such a method is expected to decrease both the cost of communication and the speed of delivering forecasts, as well as to provide much more complete data for the use of local forecasters. In this connection the San Francisco office of the Weather Bureau was very glad to know that the tests of radio reception at the Priest River Station have proven so satisfactory.

The study of the relation of the weather elements to the inflammability of forest fuels was continued the same as in the past by the systematic collection of data showing the moisture contents of duff and woody materials under different weather and forest conditions. Although this work is primarily research, it serves an administrative purpose in that the daily measurements at the several stations are used as a criterion of existing and probable fire danger. The accumulation of a great volume of measurements will be necessary before final conclusions can be drawn on the relation of each weather element to the degree of forest inflammability.

As reported last year, the measurements of duff moisture content and their interpretation into terms of duff inflammability are now generally accepted as dependable criteria for that particular type of fuel, and for the immediate vicinity of the station at which the measurements are made. It is becoming more and more evident that measurements of duff moisture, temperature, humidity, and rain, made at a single station cannot be applied generally over a large area containing greatly different elevations and timber types. If accurate measurements are wanted showing the variable fire danger factors, such as the weather and the inflammability of fuels, we must expect to install stations for making the measurements in each local weather and timber type. No expansion of the present stations is recommended for the coming year. Our first work is to determine the extent of local weather types and to perfect a dependable technique of measuring all the important factors. The present chain of stations is entirely satisfactory for these purposes.

A small amount of work was done during the past year to determine the relation between wood moisture and wood inflammability. At present,

there is no practicable method of measuring with satisfactory accuracy the inflammability of certain size classes of wood, such as slash. This could be done if the distribution of moisture in the wood could be measured. Several agencies, including the University of Montana, the Northeastern Forest Experiment Station, and the Forest Products Laboratory, are working on the problem of measuring wood moisture. With these other agencies studying the problem it does not seem desirable for the Northern Rocky Mountain Station to engage in such work. Until a successful method is evolved, however, the investigation here of wood inflammability will be seriously hindered.

Gisborne's manuscript, "Measuring Forest Fire Danger in Northern Idaho", was given its final revision during the year and sent to the Government Printing Office. It is now waiting its turn to be printed as a Department circular.

The study of lightning storms in relation to forest fires was continued as in the past and the 1927 data, consisting of over 2,000 station-storm observations, are now being coded for punch carding and analysis. This work requires less than two man-months of labor each year, aside from the time spent by lookouts and supervising officers. Major Bowie of the Weather Bureau recently stated that he felt the work was highly justified, even though no results should be obtained beyond an accurate record of the time and place of occurrence of thunderstorms. Such information is absolutely essential to the Weather Bureau if accurate predictions of thunderstorms are to be made. And it is generally conceded that such forecasts are highly essential to successful Forest protection in this region. Other information is being obtained from this study, however, which further enhances the value of the work. One of the results already in use by the field force is the knowledge that a very appreciable warning of danger can be furnished by the lookouts as soon as storms are seen. Furthermore, the degree of danger in a storm can be roughly approximated by the lookouts even before most of the fires are discovered, and administrative action is now being taken on this basis to combat the lightning menace more successfully. It is the plan to continue taking the lightning-storm records.

In connection with a more intensive assembling and analysis of District 1 fire records, a tentative working plan has been drawn up to guide the future efforts of Flint and Gisborne. A copy of the District 5 plan for punch carding such data has been obtained and advantage will be taken of their experience in such work before doing further work here. It is estimated that the time required to code the District 1 records would be about five months for two clerks. If this is done here, all the work of compilation can be done in the computing section at Washington. After that the preparation of the material in the form of a comprehensive report would require the time of one man for about six months. As stated at the beginning of this report, however, the discussion of this subject by the Investigative Committee resulted in a vote against preparing a bulletin, because of the majority opinion that a bulletin is not needed and could only be prepared at the sacrifice of more important work. This action, of course, will not stop Flint's regular assembling and correlating of fire records for District use, nor Gisborne's compilation of meteorological records bearing on the problem.

Under Hubert's direction the University of Idaho has completed one phase of its project dealing with the inflammability and heat retention of various forest fuels at different moisture contents. The work done consisted of 150 determinations of the inflammability of various kinds of needle duff at different moisture contents. At least five tests were made of each kind of duff at moisture contents of 0, 5, 10, 15, 20 and 25 per cent. The species used included: white pine, larch, spruce, cedar, and mixed. The results show that larch and cedar were the slowest to ignite and that spruce was the fastest. The relative inflammability of these species at these moisture contents, rating the least inflammable as 100, may be stated as follows: larch, 100; cedar, 99; mixed, 91; white pine, 60; spruce, 55. Such a rating does not indicate, of course, that larch is noninflammable. So far as known, this is the first time such a rating of these fuels has been possible. Similar work was done with selected species of sound and rotten wood, the rots also being identified. It is planned to repeat the tests to check the accuracy of the results and further to determine the variability which may be expected. This is valuable assistance in fire studies.

The Office of Operation has had Beatty assigned for some time to an equipment research project with the object of developing a compact and lightweight radio set for transmitting by telegraph and receiving voice or telegraph. The purpose of this work is to provide the smokechaser and mobile trail crew with a means of communication where telephone line construction is not feasible. Smokechasers especially need some method of communication which can be carried to a fire, perhaps several miles from the nearest telephone line, and which can then be used quickly to summon additional help, to call for further information from a lookout concerning the location of the fire, or to report degree of control of the blaze. The possibility of using radio on the lookouts is fairly well understood, but there has been no set available which would meet the smokechaser requirements in weight, size, and simplicity of operation. Beatty's work to date indicates that such a set can be developed. The groundwork has now been fairly well covered, including the incorporation of some new principles as well as improvements is design. After a few field tests, the equipment will be ready for submission, perhaps to experts of the Bureau of Standards, for further improvements and final design.

Previous Investigative Reports have mentioned tests of broadcasting weather forecasts by Station KUOM of the University of Montana. This work has now been discontinued because of uncertain field reception from this station and because the results were not found to justify the cost.

Further investigative work by the Office of Operation has consisted of collecting and compiling fire records for the National Forests by Flint, and for the private and State forest areas by Cunningham. Practically all of this information will be of value if the preparation of a District fire bulletin is ever undertaken.

The fire-weather forecasting work of the Weather Bureau has greatly increased its value to the Forest Service in this region. Mr. Keyser and Mr. Chapin of the Spokane office have co-operated excellently, but the funds they have available fall far short of permitting them to meet the regional needs for fire-weather research. According to the present

organization of the work, Chapin gives a large share of his time during the fire season (June 1 to September 15) to the routine reception of reports and transmission of forecasts. Mr. Keyser devotes considerable effort to the preparation of the forecasts; but that is all; there is no time for systematic analysis of the local weather reports from Forest stations nor of the mass of lightning-storm data resulting from Gisborne's study. There is no time for research of the sort necessary as a basis for much needed refinement in accuracy and localization of weather forecasts in this region.

A few examples will serve to indicate how urgent it is to have a Weather Bureau man give full time to fire-weather research in this region. In northern Idaho and western Montana there are at least four different timber types, which indicate the existence of several distinct types of climate, and, perhaps, of weather. Could not the approximate boundaries and characteristics of these climate types be ascertained and a study be made of the variations of weather peculiar to each? From discussion with District Forecasters Bowie and Sherier, information resulting from study of this sort would be fundamental to accurate and localized weather forecasts. The basic data for certain Forest weather stations are available for this. Again, the Forest Service has collected a great mass of data on the occurrence of lightning storms, which together with the available records of concurrent weather conditions, make a fertile field for studying the meteorological interrelationships. Could not this field be explored with the object of improving lightning-storm forecasts in a region where lightning causes over 60 per cent of the forest fires?

The original understanding on the part of Forest Service and private agencies in this region was that a full-time position was to be assigned to the Spokane office of the Weather Bureau for fire-weather work. At present the equivalent of only a third of one man's time is available for the purpose. It is strongly urged that a request be made of the Weather Bureau to consider the allotment of sufficient funds for maintaining a man on year-round assignment to fire-weather work at its Spokane office.

Suggestion was made in the meeting of the possibility of conducting aerological observations at certain of the high fire-lookout stations. The elevations of many of the stations are comparable to those at which measurements are taken by balloons above regular weather stations in the cities. As aerological conditions at these points are indices of weather changes, it would seem desirable to equip some of the high lookout stations with the necessary instruments. This would only be possible, however, with additional funds.

Forest Types

Larsen's report "Forest Types and Their Climatic Controls in the Northern Rocky Mountains" is in draft form. It is to be revised in the spring with a view to publication as an article in a geographical or ecological journal. His report "Physical Factors of Site in Northern Idaho" has not yet been received.

Tree Studies

Larsen's "Conifers of the Northern Rocky Mountains" is now undergoing final revision. It is planned to have it ready for submission at an early date.

Weidman is engaged on his manuscript "Timber Growing and Logging Practice in Western Yellow Pine of the Northwest" which it is planned to have ready for submission before spring.

Other Projects

Progress at the Priest River Branch Station in 1927 was marked by the addition of 11 large plots and 600 quadrats to its steadily growing series of experiments and demonstrations. Although several of the new plots were located on the demonstration forest, most of them, because of the need for fresh burns and current logging conditions were established within five to 30 miles of the Experiment Station buildings. This concentration of work in the Priest River experimental center was a follow-up of the start of the previous year to round out the permanent experiments in this locality consistent with the needs of current projects. As a result of this effort, it is now possible without long and scattered field trips to show interested foresters and lumbermen a number of experiments in yield, thinning, seed dissemination, reproduction, fire damage, and methods of cutting. By foot and auto travel from the Experiment Station as headquarters, the various experiments can be seen in a week to ten days.

Another form of development at the Priest River Branch in 1927 was the construction of 15 miles of trails in the demonstration forest. The new trails serve largely in opening up the Canyon Creek drainage which comprises about a half of the demonstration area. To complete the trail system as now planned, 13½ miles remain to be built in 1928. The total trail mileage will then be 51 miles and will mean the passage of a trail through practically every quarter section of the existing 4,265 acres of the area and the proposed 2,260-acre addition. This will adequately open up the demonstration forest to the research and protection men.

Progress was also made in the effort to give demonstration value to the 15-acre timber-sale area located a mile up Benton Creek from the Station buildings. Although cutting was completed three years ago, the area has been in an unkempt condition due to numerous snags and defective trees. The snags were all felled this winter and will be used for the Station wood supply. The defective trees will be cut as soon as another timber sale makes money available for the purpose. During the late fall four permanent methods-of-cutting plots were surveyed and partially established. These will be completed in the spring. They deal chiefly with methods of handling the understory stand, which is one of the most important problems in cutting in the western white pine type. In order to keep a good record of the cut-over area as a whole, a map of it will be made showing white pine seed trees, surface conditions, and general features of the stand before and after cutting. The white pine seed trees will be tagged and observed annually for seed production and the germination and survival of reproduction will be followed on quadrats.

Mr. Koch and the Forest Supervisor were taken into the body of virgin timber at the head of Benton Creek in the fall to size up the possibilities of a timber sale there and to get their ideas as to desirable methods of cutting to undertake in this timber. Although this stand is not of the sort that is now furnishing the pressing problems in timber-sale cutting in the western white pine type, it offers the only opportunity for cutting on the demonstration forest at the present time. As the demonstration forest is weakest in methods-of-cutting experiments, every effort is being made to negotiate a sale in this timber, and it is hoped that one may materialize in 1928. But as was stated in last year's report, there are difficulties in the form of not enough white pine in the stand to move the mixed species except under a most favorable lumber market, and a rather long haul to the river for low-value timber.

In the way of activity in selecting experimental-demonstration forests, it may be reported that joint attention has been given to the subject this winter by the District Office and the Experiment Station. As a result of interoffice conferences and subsequent correspondence with several Forest Supervisors, three areas have been selected for examination on the ground at an early date this year by members of the offices concerned. In fact one of the areas, located on the Bitterroot Forest, has already been visited. The others will be examined in the spring. The proposed areas are: one for the western yellow pine type of 2500 acres on the Bitterroot Forest, one for the larch-fir type of 7000 acres on the Flathead Forest, and the third of an intermediate size for the western white pine type on the Coeur d'Alene Forest. In addition, there is in prospect an area on the Clearwater Forest to represent the southern portion of the white pine type.

It is believed the four proposed experimental-demonstration areas, together with the two existing demonstration forests in white pine and lodgepole pine, will fairly well represent the forest types and the timber growing conditions of the region from the standpoint of soil, climate, and physiography. The Bernice area in lodgepole pine on the Deerlodge Forest covers 3000 acres. The Priest River demonstration forest is now 4265 acres in extent, but is to be increased to somewhat over 6500 acres by negotiations which are now practically concluded. The purpose of the increase is to block out and include a drainage, the principal portion of which is already in the area, and all of which logically belongs within the area. It is hoped that the four proposed demonstration forests may be designated formally for withdrawal for research purposes within a year from now.

The subject of natural areas for the preservation of virgin forest conditions has also received joint attention during the winter by the District Office and the Experiment Station. There are only three such areas already established in District 1, two containing old cedar stands on the Kaniksu Forest, and the other, on the Priest River experimental forest, containing an old mixed stand of white pine, cedar and hemlock. These range from 128 to 470 acres in extent. Nine or ten additional natural areas of 160 acres or larger are being proposed, five of them to be located in existing and proposed demonstration forests. This program will cover all the forest types in the region, including the Engelmann spruce and subalpine type. Negotiations are still in progress.

It has been the plan for some time to revive phenological observations in the northern Rocky Mountain region beginning in the spring of 1928. In anticipation of this there has been discussion and correspondence with various men interested in the subject. One result has been to receive from the Pacific Northwest Forest Experiment Station an excellent set of instructions and up-to-date forms which were prepared only last year for conducting phenological observations in that region. These and Mr. Munger's comments on their first year's experience with them have given very helpful suggestions for the instructions and forms being prepared here. It is felt here that it is much more important for success in the work to find observers who will be personally interested and competent in making the observations than to have a great number of stations. It is believed that such men can be found at about a dozen selected observation stations which fairly well cover the forest types and climatic conditions of the region. Among the men in mind are several engaged primarily in grazing work on the Forests. Although the observers will be largely Forest Service men, because of their location in or close to the Forest, it is planned also to ask the co-operation of men of the forestry and botany faculties of four colleges in the region.

FOREST PRODUCTS INVESTIGATIONS

I. REVIEW OF RESULTS - 1927

(a) General Statement

The 1927 program of the Office of Forest Products of the Forest Service as proposed and approved by the Committee has been altered somewhat during the year and certain objectives have not been attained. Several factors are responsible. The time required to complete certain projects was underestimated. Concentration of all available help was necessary during July, August, and September, in order to complete the compilation work on the Sawmill Study project. The resignation of Mr. Fullaway (Chief of Office), which became effective October 1, eliminated the possibility of completing certain objectives under his assignment.

(b) Forest Products Investigations

1. Air Seasoning - Project L-257.

The manuscript, "The Air Seasoning of Western Softwood Lumber", which was prepared jointly by Districts 1, 5, and 6, was completed and sent to Washington in May for final editing and approval.

2. Lumbering Studies

Logging Output - Although it was planned to prepare a new manuscript of these data for publication, no material progress was made, due to the change in office personnel.

Sawmill Studies - During the year the compilation, analysis and preparation for publication of the remaining data and results obtained in the studies were completed. Concentration of all available office help over a considerable period of time was necessary. Three trade-journal articles were prepared and two of them were published during the summer and fall. The third and final article of this series is now appearing in print. The length of the article necessitated its publication in four installments. The first appeared in the December, 1927, issue of the "Timberman". The article will be completed with the March, 1928, issue of the above trade journal.

An additional study was made under this project in 1927. In order to determine the depreciation occurring in fire-killed white pine, a two-week field study was made at the Dalkena Lumber Company's mill in July. Depreciation in both 1925 and 1926 fire-killed timber was determined at this time. Three thousand white pine logs were tallied through the mill by the crew of six men. One man each from the Products Offices of D-5 and D-6 assisted in the field work as members of the mill scale crew. The compilation and analysis of the data secured and a comparison with data on green timber which is available has already necessitated two months' work for a temporary clerk.

Mr. Bradner spent one week with the District 6 mill-scale crew on a project at La Grande, Oregon, the object of which was to determine the overrun obtained in western yellow pine in the east Oregon district. Bradner assisted as extra member of the crew in helping the study to get under way.

Woods Utilization Study - This study was to be initiated as a major project upon the completion of the Sawmill Studies. Due to an underestimate of the amount of work and time required to complete the Sawmill Studies, no material progress was made on this new project. A short preliminary survey was made in the field in preparation for building up a plan of work.

3. Wood Preservation

Service Test Inspections - The program outlined was accomplished with one exception, during a series of joint inspections by the Laboratory and the District. An inspection of treated lodgepole pine poles on the Beaverhead Forest was postponed until 1928.

In addition to the regular Service test inspections, as outlined in the program for 1927, numerous treating plants, private test lines, and other projects were visited jointly with Mr. Hunt of the Laboratory.

A thorough investigation was made of the experimental treating work carried on by the Anaconda Copper Mining Company in which Cold Treater Dust (arsenical flue dust) has been used as a wood preservative.

The first inspection of the Project L-263 fence posts treated by steeping and placed in fences at the U. S. Range Livestock Experiment Station, Miles City, Montana, in 1923, was also made during Mr. Hunt's field trip in the District. In this inspection detailed setting records were obtained for a report on the permanent location of the posts.

4. Little-Used Species, Project L-264.

Western Larch - The trade-journal article dealing with larch utilization was not prepared. A final report (completed in 1926), bringing together all the available data on the problem, is on file in the form of a memorandum. The purpose of this report was to provide the Laboratory with everything which may be of value in the preparation of the "Properties and Use" bulletin for larch, and to afford the basis for future work which the District must carry on with the producers. The bulletin on the properties and uses of larch has not yet been published. Preparation of the trade-journal article dealing with the utilization of western larch in this District was held up for a while pending publication of the bulletin outlined above. Change in personnel eliminated its preparation from the 1927 program.

White Fir - The status of this work is the same as that of larch. The trade-journal article on the utilization of this species in this District was not prepared for the same reasons as given for western larch above.

Lodgepole Pine - This study was considered a major project during 1927. The field work was practically completed during the summer and early fall. Considerable time was spent at the Laboratory and in Districts 2 and 4 in assembling and checking up on data already collected. A limited time was spent in getting in contact with and interviewing representatives of the larger wood-using industries of New York, Chicago, and the Rocky Mountain region, regarding the present and future use of lodgepole pine products. Some additional work was done in the office by following up (through the mail) certain leads which developed as a result of the field work.

5. Moisture Contents Project, L-252-5

While this is primarily a Laboratory project, this District assisted in the field work. The month of March was spent in the collection of wood samples and data for use in the study.

A memorandum covering several phases of the moisture-contents problem was assembled from the original air -seasoning data collected in the District. This memorandum was sent to the Laboratory in September.

(c) Forest Economic Investigations

1. Annual Lumber Census

The usual canvass of all sawmills in Montana and Idaho was made and a preliminary press notice covering the 1926 lumber production for the two States issued.

2. Prices

The following current projects were handled in the usual manner.

a. Lumber - mill
b. Lumber - retail
c. Stumpage
d. Log
e. Cedar products
f. Ties - prices and specifications

3. Lumbering Costs

a. Logging
b. Manufacturing

Average annual logging and manufacturing costs were obtained from 33 band mills. The detailed summary of these data was issued in the usual manner.

4. Timber Survey of Private Lands

No attempt was made to revise or bring up to date the information on, or status of private lands collected during the year. It was originally planned to revise the timber survey of private lands at five-year intervals. The first revision comes in 1928-29.

(d) Publications

1. To be published as a Departmental bulletin.

   a. "Air Seasoning of Western Softwood Lumber". Based on studies conducted by District 1, 5, and 6. Manuscript prepared and submitted by S. V. Fullaway.

2. The Idaho Forest and Timber Handbook, by F. G. Miller, R. N. Cunningham, S. V. Fullaway, C. N. Whitney, and C. B. Morse. Published by the University of Idaho Forest School, August, 1927.

3. Trade-Journal Articles.

   a. "Sawmill Efficiency Not Measured by Volume of Production", by M. Bradner. Published (two installments) in the July and August, 1927, issues of the "Timberman".

   b. "Utilization in the Sawmill", by M. Bradner. Published in the September, 1927, issue of the "Timberman".

   c. "Size and Defect - Important Factors in Lumbering", by M. Bradner and S. V. Fullaway, Jr. To be published (four installments) in the "Timberman". First installment in the December, 1927, issue.

4. Miscellaneous

   a. Production of Lumber and Other Timber Products in Montana and Idaho during 1926. A press notice by C. N. Whitney.

   b. The Lumber Industry of Montana. Newspaper article by C. N. Whitney for the Industrial Number of the Anaconda Standard.

   c. Monthly Trade Conditions.

II. PROGRAM OF INVESTIGATIONS - 1928

(a) Continuing Projects - Forest Products Investigations.

1. Lumbering Studies

Logging Output - It is again proposed to prepare a new presentation of the Logging Output manuscript for publication as a Departmental bulletin. An attempt will be made to complete this work early in 1928.

The Office of Management is planning on carrying on some further logging output studies during the winter of 1928 and, if possible, during the summer and fall. The Office of Forest Products will assist the Office of Management in the preparation of plans and forms and in actual supervision of the field work where this is deemed necessary.

Sawmill Studies - The remaining office work of compiling and analyzing the data collected for the determination of depreciation in fire-killed white pine will be pushed to completion as rapidly as possible in 1928. Results of the study will be published as a trade-journal article.

Wood Utilization Study - This project will have for its purpose the determination of present-day utilization in Inland Empire logging together with studies of promising methods for improved utilization. Among such studies may be listed the following; log bucking for grade, loss from breakage in felling, loss from breakage in gravity chuting, loss of footage in stump heights, together with practicable means of reducing such losses. The field is so highly complicated that a preliminary study will be required before a working plan can be prepared. Without question, such a project has great possibilities in connection with the sale of National Forest stumpage and with improved wood utilization generally. This study will be initiated as a major project in 1928.

2. Wood Preservation

Service Test Inspections, as follow, will be made during 1928:

Project L-214 - Dillon - Rattlesnake Creek Telephone Line, Beaverhead National Forest. (Creosoted lodgepole pine poles.)

Project L-214 - Spring Ranger Station - Melrose Telephone Line, Beaverhead National Forest. (Pitch-treated lodgepole pine poles.)

Project L-214 - National Bison Range Fence - Moise, Montana. (Creosoted western red cedar posts.)

Project L-214 - Creosoted posts at the Ammen place, Missoula, Mont.

Project L-50 - Northern Pacific Test Track, Plains, Montana.

Project L-50 - Northern Pacific Test Track, Thompson Falls, Montana.

3. Little-Used Species - Project L-264

Western Larch - Preparation of a trade-journal article dealing with larch utilization.

White Fir - Preparation of a trade-journal article dealing with white fir utilization.

Lodgepole Pine - This study will continue to be a major project during 1928. Considerable work is necessary in further assembling,

segregating, checking and bringing up to date the material already on file and that which is now coming in. Though the field work on this project was practically complete in 1927, a more thorough study and analysis of the data on hand may necessitate additional field work of a fairly local character. Some checking of markets and marketing conditions within the lodgepole producing centers of the region might be found advisable. Progress on the report will be pressed as rapidly as possible. It is planned to publish the results of this work in the form of a Department bulletin.

(b) Continuing Projects - Forest Economic Investigations.

1. Biennial Timber Products Census.

2. Prices
   a. Lumber - mill
   b. Lumber - retail
   c. Stumpage
   d. Log
   e. Cedar products
   f. Ties - specifications and prices

3. Lumbering Costs.
   a. Logging
   b. Manufacturing

4. Timber Survey of Private Lands.

It was originally planned to revise the Timber Survey of Private Lands at five-year intervals. The first revision would come during the winter of 1928-29, according to this plan. Data from the field have been coming in currently, so the job is principally one of compilation.

As an extension of the work already done, two things are now possible. In the area classification attempted, no reference was made to timber types. White pine blister rust control and other factors of forest management may make a division into types desirable.

In the original work all immature timber, even including denuded land, was grouped under one heading. It may be possible with the new data available to at least separate the devastated lands from the restocking burns and the 1910 burns from the 40 to 60-year-old stands. If this extension work is deemed of sufficient importance, it would seem desirable to start work during the present winter.

It is estimated that two men for two months will complete the first revision.

(c) New Projects - No new projects have been listed for the year 1928, unless the Woods Utilization Study may be considered as such. This project will be initiated during 1928, although it has previously been on the program.

(d) Publications

1. Departmental bulletins.

a. Logging Output Studies
b. Lodgepole Pine Utilization

2. Trade-Journal Articles.

a. "Size and Defect - Important Factors in Lumbering". Remaining three installments in the "Timberman", January, February, and March, 1928. Manuscript completed 1927.

b. "Depreciation in Fire-Killed White Pine Timber".

c. "The Predicament of Western Larch".

d. "The Utilization of White Fir".

3. Miscellaneous.

a. Newspaper Statement, 1927 Lumber Production of Idaho and Montana.

b. Monthly Trade Conditions.

III. WAYS AND MEANS

The program of investigations proposed for 1927 and the other activities of the office can be carried with an allotment from Products funds of $13,400. There is a decrease of $320 under the allotment for the fiscal year 1928. This decrease is due to change in personnel and salaries.

FOREST PRODUCTS INVESTIGATIONS BY THE UNIVERSITIES

The University of Idaho has eighteen utilization or products investigations under way or recently completed, as follows:

1. Determination of the cull per cent due to rot in standing timber. Report on red ray rot in P. ponderosa issued in December, 1927. Work on western red cedar to be undertaken in 1928.

2. Deterioration of logs, scattered or in piles, and methods of prevention of this loss.

3. The efficiency of chemical coatings on the ends of logs left in the woods or stored. Forest work to be on P. ponderosa and monticola in 1928.

4. The durability of western yellow pine heart and sapwood as affected by water soluble extractives and kiln drying.

5. The rots found in wood products, such as sash, doors, screen frames, etc.

6. The optimum and minimum moisture contents for the growth of wood-inhabiting fungi.

7. The cause and control of kiln brown stain in lumber.

8. The effectiveness of certain Bayer Company compounds, as sap stain preventatives.

9. The use of western red cedar for cigar boxes, chicken coops, etc.

10. The utilization of blued lumber for matches.

11. Factors influencing the movement of moisture of wood.

12. The cause and control of water core in western white pine.

13. The diagnostic characteristics of the wood of at least ten species of the genus Abies.

14. A study of bucking operations in western white pine timber.

15. Relation of moisture content of wood to the development of blue stain.

16. Outward signs of decay in standing timber and in logs. Project completed by publication of the "Manual of Wood Rots for Cruisers and Scalers in the Inland Empire".

17. The cause and prevention of sap stain in lumber. Manuscript report completed. Publication to be by the Committee on Wood Utilization of the Department of Commerce.

18. The decay resistance (durability) of native woods. A report is now in process of publication.

The University of Montana is conducting experiments on five phases of products work. Of these, Professor Ramskill is in charge of three, as follows:

1. The electrical measurement of moisture in wood. (In collaboration with Professor Shallenberger of the Physics Department.) The capacitance method is used.

2. The character of the water lost by wood during seasoning. Apparently some of the water removed from wood, below 15 per cent moisture content, is chemically combined with carbon as a carbohydrate at higher moisture contents.

3. Determination of the fiber saturation point in western yellow pine. The results of strength and shrinkage characteristics are being compared.

Professor Cook's study of effect of alignment, curvature, grade, slant of trough, and superelevation in log chutes has been dormant during

the past year, but further work is planned as soon as proper field conditions can be found for the tests on actual operations. The preliminary laboratory phases of the work are completed.

Under Professor Cook's direction a student is now comparing the efficiency of horse versus caterpillar traction of lumber in sawmill yards by wagons, bummers, and buggies.

GRAZING INVESTIGATIONS

Preliminary results of the 1927 investigative work are presented and include in some cases three years' results in order to provide a better basis upon which to judge the progress of the work.

Poker Jim Experimental Pasture - Custer

The results of the calf crop experiment for the three years are summarized as follows:

Year	Per Cent Calf Crop	Remarks
1925	52.93%	Result of ranch breeding system.
1926	42.57%	Transition year between irregular and regular breeding. Result of first year's pasture breeding.
1927	84.43%	Result of second year of pasture breeding.
1928	Should show slight increase over 1927. Increase in 1927 over ranch system due to pasture breeding management 31.5%	

Values based on $30.00 a head average valuation for this ranch.

Year	Value	Annual added return over that formerly received by the ranch on the herd due to improved management on the range.
1925	$5400.00	
1926	4350.00	
1927	8610.00	$3210.00

The average calf crop on this division of the Custer Forest for the large outfits is 56.3%. This is based on a check of all outfits of this size on and adjacent to this division. Of the total number of cattle run, 41% are breeding cows. Of the total 18,000 cattle permitted, the breeding herds have been producing 28.13% less calves than obtained this year in the pasture under improved methods.

To illustrate the money value of the extension of this system to this division in added income, the following figures are presented, using a value of $30.00 per calf produced:

No. of Calves Now Produced	Value	No. Calves Produced 1927 Pasture Return	Value	Annual Increase of Income
4155	$124650.00	6231	$186930.00	$62,280.00

This increase applied to the breeding cows run on all Forest ranges in Montana in 1927 would swell the Montana cattlemen's income $496,000.00 annually.

Due to the heavy forage crop this year, 174 head of breeding cows from the same ranch were placed with the experimental herd in the pasture. The calf crop produced by this herd, which were bred last year on the ranch, was 49.2%, as contrasted with 94.4% gained the third year from regulated breeding.

The increased calf crop feature is one of the points in better range management which is being worked out in the experimental pasture and which is being extended progressively to the Forest range. The segregation of classes of cattle to accomplish this requires fencing into large pastures the Poker Jim Pasture comprising six sections, but the increased income in one year when the plan is fully developed will more than finance all fencing required.

The experiment has also brought out the value of the segregation system in reducing to a minimum grazing trespass, reducing the time spent by owners in actual management of stock on the range, increasing the interest of the user in his range, obtaining better co-operation, reducing losses, bettering the range, reducing administrative costs, regulating carrying capacity to suit all seasons and many other points of value.

Losses

Cows to the number of 1011 run in three years suffered a loss of 1/10 of one per cent. The losses allowed in range appraisal for an equivalent time amounted to 5 per cent. With the accurate data from the pasture it is significant that the principal losses incurred are during the period when stock are off the Forest.

Volume Production Measurement on Basis of Stem Height

An easy method for determining comparative volume production of forage between areas and years is needed in grazing work. Comparative height of stems seemed a feasible one. The study made to determine the soundness of this method shows that there is no constant relation between stem and leaf production on the same area between seasons. The response to better or poorer growing conditions varies so widely between species and the stem and leaf production of the same species between seasons that the use of height growth as an index of volume production is not sound.

Utilization and Carrying Capacity

Utilization of range is largely due to the way in which stock on the range are managed, provided the range is properly stocked. The utilization in the pasture was appreciably improved by the development of better methods of handling and salting as discussed formerly. The three years' results are as follows:

Year	Utilization	Carrying Capacity	Seasonal fluctuations of forage production based on 1927 as 100%
1925	75.5%	312 for 5½ mo. season	79.93%
1926	114.93%	232 " " " "	59.50%
1927	73.78%	390 " " " "	100.00%
		Av. c.c. 311	

In 1926, 24.5% more forage was obtained than in 1925, due to development of management and salting methods.

A + E Test

A test to determine the forage acre allowance for beef cattle was carried on A+E range in 1927. Results not yet completed. This will also be used in conjunction with the Poker Jim results to determine the requirement for calves.

Salt

During the three seasons' study several outstanding points have been determined:

1. That cattle will make considerable use of salt on ranges where natural alkalies are abundant.

2. That use of salt on alkali ranges is useful chiefly to assist in the distribution of stock, and that it is not essential to the welfare of the animals themselves.

3. The principle to be followed in salt plans should be to distribute salt in relation to the dry ranges rather than to water and feed as formerly.

4. That soil and water content of sodium chloride is very small in amounts and by existing experimental data is only a fraction of the amounts necessary to maintain cattle in healthy condition.

Samples of the forage are now in the Bureau of Chemistry for analysis of their salt content. The soil, water, and forage will give the total amounts of natural salts available.

Larkspur Eradication. Beaverhead-Madison.

The use of Atlas Weed Killer in solution was begun this year on test areas on the Beaverhead and Madison. The tests were made with two concentrations, 4 to 1 and 9 to 1. The solution was injected into the plants by means of a veterinarian's hypodermic syringe by four methods:

1. In hollow stem at root crown.

2. In hollow stem half way between top of plant and ground.

3. Breaking off and injecting directly into stem.

4. Spraying plants at base of stem.

Plants were staked and numbered and marked with concentration and method used. The time used for each method was recorded and costs of treatment figured for each operation to determine if the method is cheaper in application than the grub-hoe method. Results will not be available until growth of treated plants is checked next season.

Carrying-Capacity Studies

Studies to determine the forage acre allowance on various ranges were initiated on the Jefferson and Madison this year. Data not yet completed.

Protection by Enclosures

The fenced enclosures in the pasture show that after three years' protection an increase of 5.92% has been obtained as a result of complete protection from grazing as against grazed range. This increase was made chiefly during 1927, the third year of protection.

Co-operative Experiment with the University of Montana

Dean Spaulding is continuing his co-operative project in testing the seed of forage plants. This work was commenced in 1925 with the collection of 288 seed samples by Forest officers, and subsequent testing by the University. During 1927, the collection of samples was much more carefully done and tests of these are now in progress. Due to the variations in the numerous factors involved, it is planned to continue this work over a period of at least five years before attempting to report results.

Lines of Work

Seasonal Studies

Studies to determine dates of vegetative readiness and the management of stock on the spring ranges were carried on the Jefferson, Deerlodge, Lewis & Clark, Beaverhead and Beartooth.

Improved Methods of Handling Stock

This is being actively carried on the Custer, Lewis & Clark, Helena, Beaverhead, Beartooth, Selway and Clearwater.

New Projects

An experimental pasture similar in scope to the Poker Jim project will be started on the Crow Creek range on the Helena in 1928.

FOREST ENTOMOLOGY

The following statement was submitted to the District Investigative Committee by Mr. J. C. Evenden, in charge of the Coeur d'Alene Forest Insect Field Station.

Introduction

Several years ago an investigative program was adopted by the Forest Entomology Branch of the Bureau of Entomology for the Coeur d'Alene Station, which covered in detail the most important forest insect problems which confronted us at that time. Since the adoption of this program, it has only been possible to work upon a few of what we considered the more pressing of the projects assigned. Our efforts have been directed towards the protection of the mature timber stands within the Forests of this District. We have worked toward the development of more economical and effective control measures for the suppression of bark beetle epidemics, and a better understanding of the ecological factors affected by the application of control measures.

Forest Insect Control Projects

Inasmuch as at this time our control projects are all experimental in character, they have always been included in our investigative program. This policy is continued as we feel that in the proper application of control measures we must recognize the necessity for sufficient flexibility to fit the vast differences met with on each succeeding project, and this can only be determined by considering each project an experiment.

Big Hole Basin Project -- Beaverhead National Forest

This Big Hole Basin control project is directed against an epidemic of the mountain pine beetle (Dendroctonus monticolae) which apparently has been spreading southward along the Continental Divide for many years. During the 1927 season control measures were continued in accordance with the plan of control as adopted in 1925 by the Bureau of Entomology and the Forest Service. It is hoped that as the infestation spreads from the East Fork of the Bitterroot River into the Big Hole Basin all or a large per cent of the infested trees can be treated each year, the epidemic checked and the valuable timber stands to the south protected. This project will need to be continued until such time as the epidemic on the Bitterroot, from which the reinfestation occurs, no longer exists. During the past season 17,546 trees were treated at an actual cost of $31,205, or $1.77 per tree. This is a reduction over the previous year's work of $0.50, or 22 per cent. The work was greatly handicapped by weather conditions which undoubtedly raised the cost of treatment and prevented the covering of the entire area. During the past summer it was found that the infested area was far larger than had heretofore been assumed, and that in 1928 a large expenditure of funds would be necessary if the work was to be at all effective. In view of the timber values at stake, it was believed that such an expenditure was justified, and if the funds are made available, the project will be continued in 1928.

Pete Creek Control Project -- Kootenai National Forest

It will be recalled that in the spring of 1926 control measures were instituted in the Pete Creek drainage of the Yaak River in an attempt to reduce an outbreak of the mountain pine beetle (Dendroctonus monticolae) in an isolated area of white pine. This project was regarded as being entirely in an experimental light, as a few miles to the north there existed a very severe epidemic of this insect in lodgepole pine. Though there was no physical connection in the infestation between these two areas, there could be no assurance that the inception of the outbreak in the white pine had not come from the lodgepole pine a few miles to the north. However, due to the valuable entomological data to be secured and the timber values at stake, it was felt that the cost of the experiment was more than justified. At that time 693 infested trees were treated at a total cost of $3.73 per tree. A subsequent survey of the area showed that during the summer a rather severe reinfestation occurred, and it was again necessary to institute control measures during the season of 1927. Approximately 660 trees were treated during the past season at a total cost of $2.54 per tree, which is a reduction over the previous season of $1.19, or 31 per cent. This shows still more progress in the administrative application of our present methods of control. During the fall of 1927 an extensive survey was made of this area and considerable reinfestation was found, even after the region had been very thoroughly cleaned by control measures during the past two seasons. This fact seems to leave but little doubt that the annual reinfestation within the area had come from the lodgepole pine epidemic to the north. However, in other areas of white pine within this Forest, not adjacent to lodgepole pine infestations, outbreaks of the mountain pine beetle are occurring which can only be accounted for by considering them as local outbreaks. In view of these conditions and existing timber values, if funds are available, it is planned to continue the Pete Creek project, and to institute control measures within the Meadow and O'Brien Creek drainages.

INVESTIGATIVE PROGRAM

Of the many investigative projects assigned to this station only those on which some work has been conducted during the past season will be included within this report.

I.

Bureau Project #1 -- Analysis of Effect of Artificial Control.

Object -- To determine:

1. Per cent of total infestation treated and amount of reduction obtained on areas covered by control work.

2. Reduction obtained on untreated areas, adjoining control areas and extent of influence of control work.

3. Comparative effectiveness of spring, fall and summer work.

4. Length of time that results are effective.

Accomplishments and Plans -- Surveys of all control projects listed in this report have been made.

In 1928 a survey of the Hunter Gulch and Magpie control projects of the Helena National Forest will be made. On both these areas local outbreaks of the mountain pine beetle in lodgepole pine were successfully reduced by artificial control measures a few years ago. Surveys of all going control projects will be continued.

II.

Bureau Project #2 -- Economics of Control Management.

Object -- 1. To determine from projects now under way what methods of administration and organization of work can be employed to reduce costs and increase efficiency of control work.

2. To determine the cost basis upon which control work is warranted by economic considerations.

Accomplishments and Plans -- A careful analysis of the past season's control cost, treating and spotting crew administration, production data, etc., has been made for all projects. During the 1928 control season a marked reduction from the previous year's cost was made by the Forest officers in charge of these projects.

The above study in connection with all going control projects will be continued, and it is hoped will lead to still further reduction in the cost of control.

III.

Bureau Project #3 -- Possibility of Maintenance Control and Its Relation to Forest Management.

Object -- 1. To determine extent to which artificial methods of control can be employed to prevent endemic infestations from becoming epidemic.

2. Phases of the management of forest lands which will contribute to holding infestations to an endemic condition.

Accomplishments and Plans -- The Independence Creek project, Coeur d'Alene National Forest, which for several years had been conducted in connection with this experiment, was destroyed by fire in 1926. During September a survey of the Elk and Cascade Creek drainages was made for the purpose of locating another region suitable for the continuation of this study. This survey showed that there was a normal infestation within these two drainages and that they were suitable for the proposed study.

If funds and time are available, it has been recommended that a sufficient allotment be made for the institution of control measures within these two drainages. The project would be continued annually for a period of five years, in order to test the conomics of instituting our present methods of control against normal infestations of the mountain pine beetle in white pine.

IV.

Bureau Project #4 -- Possibility of Extermination.

Object -- To determine if extensive control on areas protected from infestation coming in from the outside will result in final extermination of bark beetles.

Accomplishments and Plans -- This project is very closely associated with Bureau Project #3, (Possibility of Maintenance Control and Its Relation to Forest Management), and the same information given under that caption will apply to this. It is trusted that it will be possible to inaugurate this project in the very near future.

V.

Bureau Project #5 -- Possibility of Developing Better Control Methods.

Object -- To develop more effective and less expensive methods than the ones now in use and to improve existing methods of bark bettle control.

Accomplishments and Plans -- As has been previously stated in this report, improvement in our present methods of control along the lines of equipment and crew organization resulted in a marked lowering in the cost of treatment. It is hoped that during the coming season additional improvements can be made which will still further increase our output per man-day.

Burning of Standing Infested Trees

Considerable experimental work was conducted on this method of control in connection with the Big Hole Basin project. Mr. W. W. White gave valuable assistance in the work and in starting the crew formen in the use of the method. It is believed that this method can be used to good advantage under certain weather conditions with certain types of trees. Low, scrubby, heavily-limbed trees are best adapted to this treatment. In addition to being the most suitable for this method, this class of tree is the most expensive to treat by our felling and burning method. The trees treated in this manner should be somewhat isolated in order to prevent the scorching of uninfested trees. Such control cannot be used to advantage under extreme wet or dry conditions. The use of oil is most surely an aid in the application of this method, but is not essential if sufficient brush can be secured to place at the base of the tree.

Experimental Treating by Notch-Girdling

Following a theory that if the root system of an infested tree was severed from the crown the bole would dry sufficiently so as to make the development of the broods impossible, a few trees were notch-girdled in 1925. Examination of these trees in 1926 showed a very high mortality and gave promise of being acceptable as a control measure, but the amount of data was too small to furnish a definite conclusion. A much larger number of trees was similarly treated in 1926 and examined in 1927.

The treated trees showed a potential emergence amounting to 113% of the number of insects attacking, while untreated trees showed 130%. The slight difference in favor of the notch-girdled trees is too small to make the method worthy of consideration. The results were a direct contradiction of the leads developed in 1926 and apparently proved that notch-girdling need not be considered further as a possible control method.

Experimental Treatment by Felling on Logs

The treatment by felling on logs was inaugurated under the theory that by severing the root conections and allowing the foliage to remain, such excessive dryness might be secured which would result in the destruction of the broods. Trees treated in this manner in 1925 and examined in 1926 gave sufficient promise to warrant the continuation of the experiment in order to secure more conclusive data, and a much larger number of trees were treated in 1926. Examination of these trees during the past season showed a potential emergence of only 50.5% of the number of insects attacking and a retardation in brood development of 20 days. Though the entire brood is not killed, the potential emergence has been reduced to 50.5% of the number of insects attacking, while for untreated trees it is 130%. This fact offers some promise of its being a possible method of treatment. There is still further the brood retardation which is of unknown control value, but it has been suggested that the normal development of the insect in relation to its host may be disturbed. This might consist of the later attack resulting in a shorter gallery, with fewer eggs and a much smaller emergence.

This experiment is being continued and the coming season's data are expected to furnish more conclusive evidence of its value.

Experimental Treatment by Felling and Trimming

In this experiment it was hoped that by severing root connections and removing all limbs and foliage so that all tree moisture would be retained, drowning or bacterial action would be caused, which would be destructive to the brood. Trees so treated in 1925 and examined in 1926 gave sufficiently favorable results to warrant continuing the experiment. The trees examined in 1927 showed a potential emergence 45.3% of the attack and a brood retardation of 17.6 days.

The same conclusions and plans as in the previous experiment apply to this one. It is further hoped that a study may be made of the effect of retarded development on brood mortality and subsequent attack. This can best be done by treating in the above manner all of the infested trees within an isolated infestation, and checking the results obtained.

Destruction of Brood by Solar Heat

The data so far secured show too uncertain results to warrant present consideration as an economical method of control.

No further work is planned on this experiment at present.

Destruction of Brood by Injecting Poison in Standing Trees

In the summer of 1926 a small amount of poisoning of infested lodgepole pine was instituted. It was hoped that either the poison would directly kill the infesting brood by poisoning or else so hasten the cessation of life processes in the tree so as to render the insect food unfit for consumption, and thus kill the insects. The results obtained in 1926 were not very definite and another method was evolved. This was initiated during the first week of August of 1927 and consisted of injecting into the tree one or two quarts of sodium arsenate or arsenite dissolved in water, using varying strengths of the solution. Twenty lodgepole pine were so treated each week for six successive weeks. Records were kept periodically of the foliage changes in the treated trees from time of treatment until the end of the field season. The foliage was very quickly killed, but the insects were apparently unaffected. It is hoped, however, that this early killing of the foliage may result later in high mortality in the insects by changing their food and other environmental factors.

It is planned to secure brood development and potential emergence data from these trees during the 1928 field season. This data will be compared with untreated trees to determine effectiveness.

Life History Study

While there is a fair knowledge of the life history of the mountain pine beetle, many points remain upon which our data is meager or lacking. The past two seasons' work has resulted in a more general knowledge of the average number of eggs per foot of gallery, attacks per square foot, gallery length, etc. The length of the period for the development of each stage in the seasonal history of this insect, and a knowledge of the factors causing brood mortality are becoming more definitely known.

The above life-history studies will be continued through the 1928 season, and it is hoped that other phases of this project can be undertaken. There is need to know more of the time element relative to the beginning, duration, and cessation of attack, as well as the factors which contribute to the extreme of attack. The importance of the effect of brood retardation as secured in our experimental control should be investigated. Realizing that there is a difference in brood conditions in the advance and other parts of the infestation, a study for the purpose of comparing these differences should be made.

Effect of Temperature on Brood Development

During the past season considerable date were secured on under-bark temperatures of both experimentally treated and untreated lodgepole pine. Weather records for the area and air temperatures adjacent to each subcortical temperature experiment were also kept. These data should furnish valuable information as to the relationship of temperature and brood development.

If the data, which as yet have not been worked up, do not furnish the information desired, additional work will be conducted in 1928.

VI.

Bureau Project #10 -- Relation of Condition of Tree to Primary Attack by Bark Beetles.

Object -- 1. To determine relation of factors such as age, rate of growth, vigor, and artificial condition such as produced by girdling, felling, scorching, grazing, soil conditions, and defoliations upon attacks by Dendroctonus beetles.

2. To determine if weakened resistance of the trees due to these causes is reflected by increasing bark bettle infestations and if recovery of the trees results in decline of the infestation.

Accomplishments and Plans -- During the field season of 1926 increment cores from all sample-plot trees were collected. Subsequently each of the last ten annual rings was measured and the biometric correlation found between rate of growth and susceptibility to insect attack. The slower-growing trees were found to be but slightly more susceptible to attack. While the data used were meager for such a study, it is believed that rate of growth is but a minor factor in influencing attack. No further work is planned on the objective just discussed.

Tree Selection by Insects

This work has been started in a small way in the sample plots that have been established. From them we hope to secure some idea of the relative preference of the insects for certain trees by observing those trees attacked by them in succeeding years.

VII.

Bureau Project #11 -- Insects and Forest Fires

Object -- To determine the interrelation of insects and forest fires, and to determine the effects of fire in breeding up epidemics.

Accomplishments and Plans -- The Coeur d'Alene Station is co-operating with the Experiment Station in their fire-reproduction study. This co-operation has furnished some valuable data upon which to base the institution of such studies which it is hoped can be undertaken in an adequate manner in the very near future.

CONCLUSIONS

For accurate tests of the methods of control which have been experimentally developed, it will be necessary to make practical field applications of them. This is especially true in determining the entomological value of brood retardation. In order to make such tests, infestations of a few hundred trees should be located, which are isolated from other infested areas. This isolation is necessary so as to remove all danger of outside influences.

In the application of such experimental methods to such an area, all of the infested trees would be treated, and the value of the method determined from the results obtained. As a natural fluctuation is nearly always present in bark bettle outbreaks, such tests should be carried over a period of years in order to be certain of any positive results obtained. It is requested that all areas of this character be reported to the Coeur d'Alene Station.

OFFICE OF BLISTER RUST CONTROL

As Cronartium ribicola has been found during the past year on Grossularia inermis about seven miles north of Priest River, Idaho, and as it is certain that for every first discovery like this there are actually many other infections near by, the report submitted by Mr. S. N. Wyckoff is exceptionally important. The statement of the research work in blister rust control is as follows:

Experimental Projects Conducted in 1927

Projects which have been under way in District 1 during the past year are as follows:

1. Experimental Ribes eradication
   a. Hand pulling.
   b. Chemical eradication.

2. Control reconnaissance.

3. Ecological studies of Ribes.

Experimental Ribes eradication by hand-pulling methods was conducted in the Little North Fork drainage, on the Coeur d'Alene National Forest. Because of the heavy concentrations of Ribes, the average cost per acre was higher than in 1926. The two following tables give a brief summary of this type of experimental Ribes eradication which has been carried on since the inception of this work:

Table No. 1

Summary of Experimental Ribes Eradication in Idaho

Year	Location of Work	Acreage Worked	Ribes per Acre	Cost per Acre	Efficiency of Work: By No. of Bushes	Efficiency of Work: By Feet of Live Stem
1922	Elk River, Idaho	414	69	1.44	71.33	81.50
1923	Priest River Experiment Station, Idaho	1,698	31	1.91	-	-
1924	Upper Priest River, Idaho	5,517	48	1.65	76.29	85.52
1925	Upper Priest River, Idaho	4,260	86	3.83	83.96	94.12
1926	West Branch Priest River, Idaho	8,865	43	1.26	91.16	94.98
1927	North Fork Coeur d'Alene River, Idaho	16,437	126	2.40	86.47	95.59

Table No. 2

Experimental Ribes Eradication
According to General Types

Year	Location of Work	Stream: Per Cent Acreage	Stream: Cost Per Acre	Reproduction Forest: Per Cent Acreage	Reproduction Forest: Cost Per Acre	Pole and Mature Forest: Per Cent Acreage	Pole and Mature Forest: Cost Per Acre
1922	Elk River, Idaho	8.81	$11.49	26.57	$.97	64.62	$ .17
1923	Priest River Experiment Station, Idaho	9.12	16.16	-	-	90.88	.48
1924	Upper Priest River, Idaho	4.64	6.60	41.83	2.17	53.53	.79
1925	Upper Priest River, Idaho	3.51	8.14	64.23	5.04	32.26	.89
1926	West Branch Priest River, Idaho	5.66	9.87	15.93	1.03	78.41	.69
1927	North Fork Coeur d' Alene River, Idaho	6.71	13.25	25.62	3.38	67.67	1.03
	Average	5.66	$11.46	28.77	3.17	65.57	$ .85

Experimental chemical eradication was again carried on in the St. Maries River drainage. The results secured further substantiate the conclusion that Ribes petiolare, the Ribes species most susceptible to the rust and most difficult to eradicate by hand pulling, can be more efficiently and cheaply eradicated by means of chemicals. The most effective substance yet found is sodium chlorate, $NaClO_3$. This has been secured from the Chipman Chemical Company, Palo Alto, California, being marketed under the name of Atlas N. P. Weedkiller. This chemical will consistently kill 96% of Ribes petiolare, but is less effective on other species. It thus far shows a 51% kill on R. lacustre and a 39% kill on G. inermis. Investigative work on the effect of halogen and oxyhalogen compounds on different Ribes species is now being carried on. It is hoped that these investigations will pave the way for higher killing efficiency on Ribes species other than R. petiolare, and for a further decrease in the cost of the chemicals used.

Control reconnaissance was continued during 1927, in North Idaho, northwestern Montana, and to a limited extent in northeastern Washington. Since the beginning of this work, 685,044 acres of white pine type have been covered. The results are of special value in developing general plans for local control, and for determining the amount of white pine type so sparsely populated with Ribes that eradication will not be necessary.

Ecological studies of Ribes, which have been continued during 1927, have now progressed to the point that some definite conclusions can be made. These can be briefly summarized as follows:

1. Ribes are a temporary and not a permanent part of the flora of well-stocked white pine stands.

2. Ribes appear in the white pine type following disturbance of the ecological conditions existing in a well-stocked forest stand. Such disturbance may take the form of partial or complete removal of the forest cover by fire or logging operations, with attendant partial or complete destruction or removal of the duff. It is further known that duff disturbance without an opening in the forest canopy will cause germination of Ribes seeds, but the survival of the seedlings is as yet uncertain.

3. Ribes seeds retain their viability for long periods when stored in the duff. When conditions are favorable, they will germinate and establish a new Ribes population on the area.

4. Complete duff destruction, due to such causes as very hot fires, results in the establishment of fewer Ribes than partial destruction of the duff, as caused by very light fires.

5. If a dense and well-distributed stand of reproduction is secured after logging or fire, the Ribes will be killed out in from 10 to 40 years, depending upon the density of the reproduction and the degree of stocking with Ribes.

6. Because of lack of forest cover, certain small areas in a forested region constitute permanent rather than temporary Ribes sites. The most important of these is the stream type, or narrow belt of brush growing along streams. Secondary permanent Ribes sites are spots in the forest where the forest cover is permanently broken, due to such causes as rock outcrops, and swampy places.

Spread of the Rust

White pine blister rust was found for the first time in Idaho during the autumn of 1927. A single infected plant of Grossularia inermis was found about seven miles north of Priest River, Idaho. Due to the intensification of pine infection in the vicinity of Nelson, British Columbia, and the moist spring of 1927, the appearance of the rust in North Idaho was to be expected. Numerous Ribes infections were found in northeastern Washington, their number being due to the shorter distance from infected pines and the prevalence of Ribes petiolare, a very susceptible host.

Following the discovery of the rust, the Office of Blister Rust Control made a summarization of all available data which pertain to the application of local control. The conclusions reached upon the basis of this summarization, and the recommendations made to the Forest Service, the State Foresters concerned, and the timber operators are as follows:

1. Any plan for application of control must necessarily give consideration to two phases of work; (1) establishment of

control, and (2) maintenance of control.

2. Before a general control plan can be put into operation, boundaries must be established within which will lie all the white pine area of the Inland Empire to be permanently managed for white pine, and which must therefore, sooner or later, receive either natural or artificial protection.

3. A logical plan for control of blister rust in the Inland Empire, based upon the minimum requirements which will meet the situation, is as follows:

(a) Establishment of control:

First step - Ribes eradication and re-eradication in the stream type before heavy damage results.

Second step - Ribes eradication in those reproduction stands which will suffer damage before Ribes are naturally eliminated.

Third step - Ribes eradication in maturing stands where the Ribes factor, even if decadent, is too great to allow the stand to mature without serious damage.

(b) Maintenance of control:

First step - Periodic checks of stream type to maintain a Ribes free condition.

Second (and coincident) step - Re-eradication, in any reproductive and maturing stands where this is necessary, until natural control starts.

Third step - Eradication on newly logged and burned areas until natural control starts.

4. Time element. The scale of work necessary to accomplish blister rust control in the western white pine region will be so large that it cannot be applied instantly, but in the interest of economy and effectiveness must be carried forward in progressive steps. Considering the size of the job and the huge personnel problem which it will create, it will require a minimum of 15 years to establish the control work once it is properly under way. Any delay in beginning the control work will necessarily further delay its completion and, therefore, increase the danger of heavy damage to the pine areas upon which the application of control work is delayed.

5. It is recommended that in the season of 1929 a large scale operation be started to secure general Ribes eradication in the stream type of the Inland Empire white pine belt. This stream type should be gone over twice and finally checked over by the end of the 1936 season, or eight years after the inception of the work.

6. After the stream type eradication is completed, or in some cases possibly before, those stands of reproduction which will be damaged by the rust before they can naturally free themselves of Ribes must be protected.

Projects Contemplated for 1928

While plans for the 1928 field season are as yet only tentative, it is probable that the following projects will be carried on in District 1.

1. Ribes eradication at the Savenac Nursery, Haugan, Montana.

2. Ribes eradication, on a co-operative basis, on State lands, Idaho.

3. Experimental Ribes eradication project on the Coeur d'Alene National Forest, Idaho.

4. Large scale experiment in the application of chemical eradication in North Idaho. Exact area to be chosen according to the size of the field unit.

5. Control reconnaissance in the white pine type.

6. Continuation of ecological studies.

7. Continued scouting for the rust.

FOREST RESEARCH ACTIVITIES IN 1928

UNIVERSITY OF IDAHO

A. Four studies in co-operation with the Spokane office of Blister Rust Control, Dr. Hubert in charge.

1. Plot studies of Ribes.
2. Germination of Ribes seed.
3. Identification of one-year-old conifer seedlings.
4. Forest management as a method of control.

B. Forest Products and Utilization studies. Dr. Hubert, except as noted.

1. Cull per cent due to rot in standing timber.
2. Deterioration of piled and scattered logs.
3. Chemical end coatings for logs.
4. Outward signs of decay in standing timber and logs.
5. Cause and prevention of sap stain in lumber.
6. Decay resistance of native woods. A. M. Sowder.
7. Toxicity of water soluble extractives. B. A. Anderson.
8. Decay of sash, doors, screen frames, etc.
9. Wood moisture and the growth of fungi.
10. Cause and control of kiln brown stain.
11. Sap stain preventatives. Boyce Thompson Institute.
12. New uses for western red cedar.
13. Blued lumber for matches.
14. Movement of moisture in wood.
15. Moisture content and inflammability of certain forest fuels.
16. Water core in western pine.
17. Moisture content in relation to blue stain.
18. The moisture-absorbing and holding capacity of various tree-packing materials. A. M. Sowder.

19. The diagnostic characteristics of the woods of the genus Abies, by species. Professor Wiesehuegal.

C. 1. Thermal conductivity of wood at various moisture contents. Dean M. F. Angell, Physics Department.

D. Volume, Growth, Yield, etc.

1. Empirical yield tables of young even-aged western white pine stands in the Potlatch region. Professor Watson.

2. Permanent sample plots in residual stands of western white pine. Professor Watson.

3. Effect of logging on the growth and form of residual trees in a western white pine operation. Professor Nettleton.

4. Bucking operations in white pine. Professor Wiesehuegal.

5. Empirical yield tables of white pine in the Clearwater region. Professors Nettleton and Wiesehuegal.

6. Growth and yield of western yellow pine. Professor Taylor.

7. Influence of windbreaks on farm and orchard crops. A. M. Sowder, Research Assistant.

8. Tree planting on alkali soils. A. M. Sowder.

9. Planting at high altitudes. A. M. Sowder.

FOREST RESEARCH ACTIVITIES IN 1928

UNIVERSITY OF MONTANA

A. Seed Studies

1. Stimulating germination of 57 varieties of seeds. Professor Skeels.

2. The viability of the seed of eastern Montana forage plants. Dean Spaulding.

B. Volume, Growth and Yield.

1. Normal yield tables for even-aged western yellow pine. Professor Skeels.

2. Growth and yield of western yellow pine on permanent plots. Professor Skeels.

3. Use of the Form Quotient in timber estimating. Professor Clark.

C. Products and Utilization

1. Design and efficiency of logging chutes. Professor Cook.

2. Lumber transportation in the mill yard. Professor Cook.

3. Electrical measurement of moisture in wood. Professor Ramskill and Professor G. D. Shallenberger of the Physics Department.

4. Character of the water lost by wood in seasoning. Professor Ramskill.

5. Fiber saturation point of western yellow pine. Professor Ramskill.

RELATIVE URGENCY OF EXPERIMENT STATION PROJECTS

The following statement shows the effort devoted to the various projects on the program in 1927 and the order in which effort is to be placed in 1928, on the basis of project costs by the year:

Order of Effort in Calendar Year 1927

Project	Cost by Per Cent of Allotment
Yield	30°
Reproduction	18
Weather and Fuel Inflammability	15
Demonstration Forest	13
Methods of Cutting	10
Planting	4
Lightning and Forest Fires	3
Fire-Weather Forecasting	3
Public Requirements	2
Thinning	1
Miscellaneous	1
	100

Order of Effort Planned for Calendar Year 1928

Project	Estimated Per Cent of Allotment
Methods of Cutting	27
Weather and Fuel Inflammability	15
Reproduction	15
Demonstration Forest & Exp'tal Centers	15
Yield	12
Public Requirements and Yellow Pine Reports	9
Lightning and Forest Fires	3
Fire Weather Forecasting	2
Thinning	1
Miscellaneous	1
	100

°This figure is based on a Station allotment total increased by Washington Computing funds devoted to this project.

ARTICLES AND PUBLICATIONS BY EXPERIMENT STATION

Submitted for Publication

1. "Measuring Forest Fire Danger in Northern Idaho", H. T. Gisborne. Submitted June, 1926. Department Circular.

2. "The Importance of Lightning as a Cause of Forest Fires", H. T. Gisborne. Submitted October, 1927. Article.

3. "Effect of Ceanothus Brush on Western Yellow Pine Plantations", W. G. Wahlenberg. Submitted March, 1927. Article.

4. "Influence of Size of Western Yellow Pine Seeds on Behavior of Forest Planting Material", W. G. Wahlenberg. Submitted March, 1927. Article.

5. "Experiments in the Use of Fertilizers at Savenac Nursery", W. G. Wahlenberg. Submitted May, 1927. Article.

6. "Classes of Stock Suitable for Planting in Northern Idaho", W. G. Wahlenberg. Submitted November, 1927. Article.

7. "Effect of the Amount of Seed Sown and the Density of Seedlings on the Later Development and Survival of Western Yellow and White Pine and Engelmann Spruce", W. G. Wahlenberg. Submitted November, 1927. Article.

8. "Modification of Western Yellow Pine Root Systems in the Nursery", W. G. Wahlenberg. Submitted January, 1928.

9. "Forest Research Activities in the Northern Rocky Mountain Region", R. H. Weidman. Submitted December, 1927. Article to Northwest Science.

10. "Life History of Some Western White Pine Stands on the Kaniksu National Forest", Robert Marshall. Submitted December, 1927. Article to Northwest Science.

11. "Nonindigenous Western Yellow Pine Plantations in Northern Idaho", Gerhard Kempff. Submitted December, 1927. Article to Northwest Science.

Published in 1927

1. "Prolific Seed Production in the Forests of Northern Idaho", R. H. Weidman. Northwest Science, Vol. 1, No. 4, December, 1927.

2. "Meteorological Factors in the Quartz Creek Forest Fire", H. T. Gisborne. Monthly Weather Review, p. 56, 1927.

3. "The Objectives of Forest Fire-Weather Research", H. T. Gisborne. Journal of Forestry, p. 452, 1927.

4. "An Investigation of Lightning Storms in the Northern Rocky Mountain Region", H. T. Gisborne. Northwest Science, Vol. 1, No. 4, December, 1927.

5. "Volume Production in Forestry Literature", Robert Marshall. Journal of Forestry, p. 178, 1927.

6. "Influence of Precipitation Cycles on Forestry", Robert Marshall. Journal of Forestry, p. 415, 1927.

7. "Planting Pine Among Brush", W. G. Wahlenberg. Timberman, Vol. 28, No. 5, March, 1927.

Proposed for Preparation in 1928.

1. "Timber Growing and Logging Practice in Western Yellow Pine in the Northwest", R. H. Weidman.

2. "Results on Permanent Sample Plots in Western Yellow Pine Ten Years After Cutting", R. H. Weidman.

3. "A Silvicultural Study of Western Yellow Pine in the Northwest", R. H. Weidman.

4. Articles on phases of "Measuring Forest Fire Danger in Northern Idaho" to be taken from the Department Circular when published. H. T. Gisborne.

5. "The Effects of Fuel Moistures on Fire Temperatures", H. T. Gisborne.

6. "The Effects of Fire Temperatures on Forest Seed in the Duff", Robert Marshall.

7. "Intensive Reasearch in an Open-Air Laboratory", Robert Marshall. (For American Forests and Forest Life)

8. "Reproduction Following Fire and Logging in Northern Idaho", Robert Marshall.

9. "Western White Pine Yield Study", I. T. Haig.

10. "Ten Years of Growth and Loss on Three Permanent Yield Plots", Gerhard Kempff.

11. "Results of Thinning Experiments in Western White Pine", Gerhard Kempff.

EXPERIMENT STATION STAFF

R. H. Weidman	Director
H. T. Gisborne	Associate Silviculturist
I. T. Haig	Assistant Silviculturist
G. Kempff	Assistant Silviculturist
R. Marshall	Assistant Silviculturist
Margaret H. Troop	Clerk

EXPERIMENT STATION BUDGET F.Y. 1929

	SI	GED-1	Imp.
Salaries (permanent staff)	11,900	3,960	
Expenses (permanent staff)	1,900		
Salary & Expenses of field assistants	1,500		
Rent	880		
Maint. & Operation of two autos.	325		
Equipment and Supplies	400		
Freight, Express and Hauling	100		
Maint. & Admin. Branch Station		480	525
Maint. Team of Horses		200	
	$17,005	4,640	525